

Data Integration and Inference: from Biobridge to Synergy

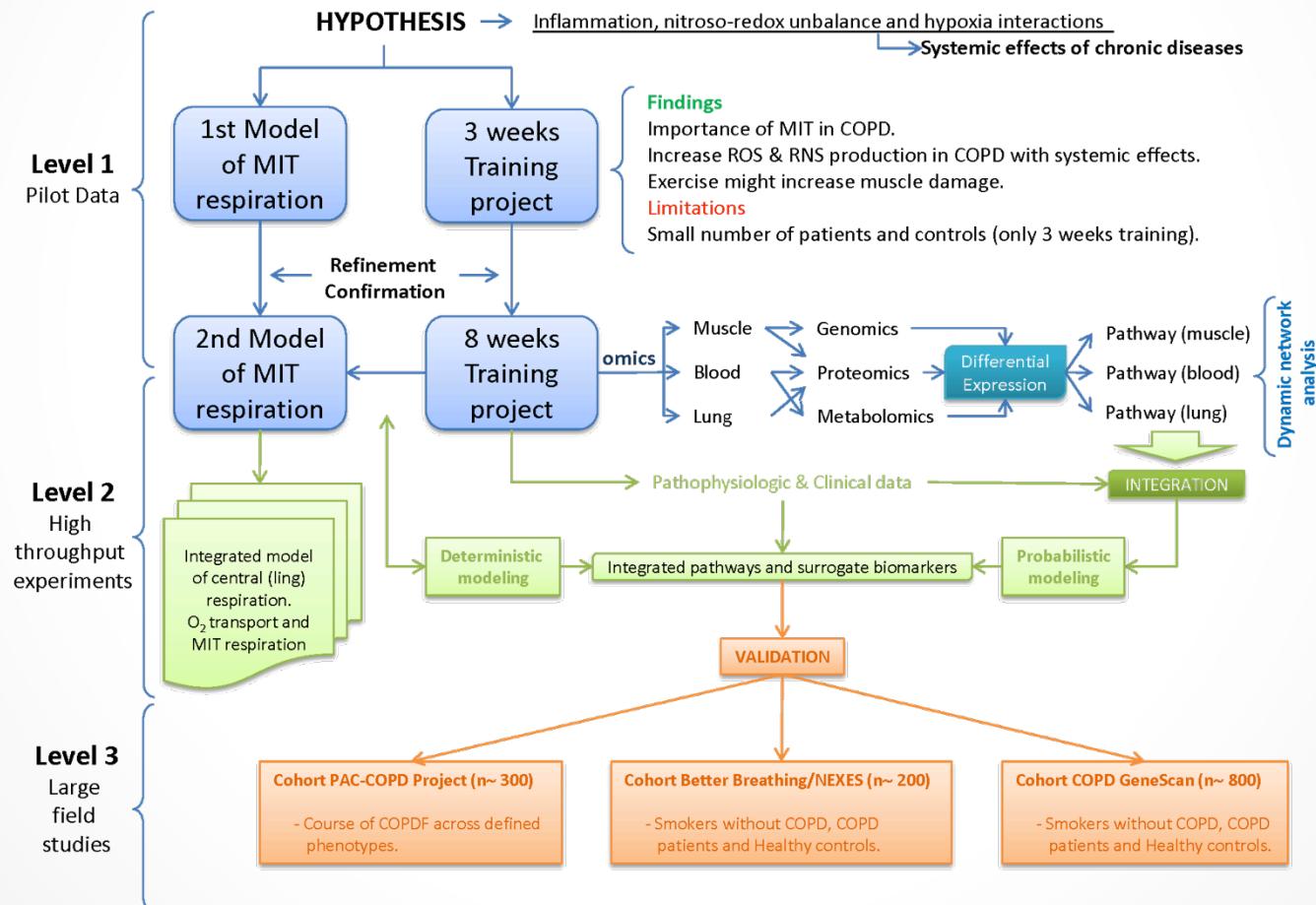


The BioBridge Project

Integrative Genomics and Chronic Disease Phenotypes:
modelling and simulation tools for clinicians



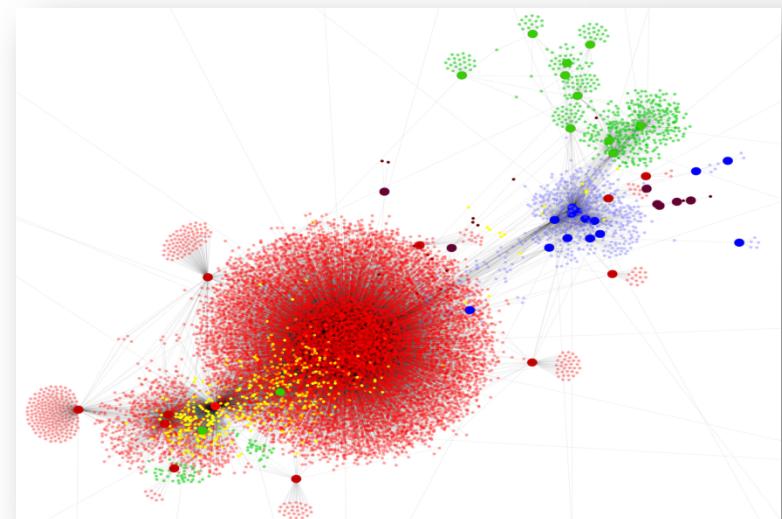
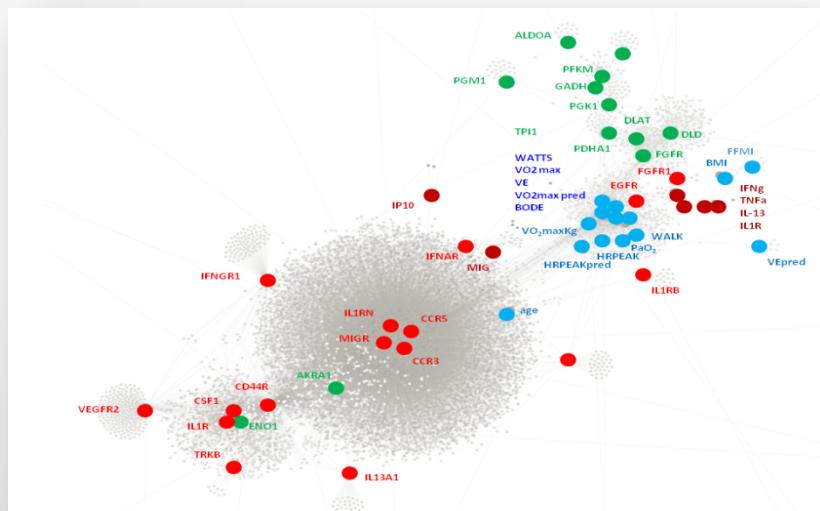
The BioBridge project



Biological Outcomes

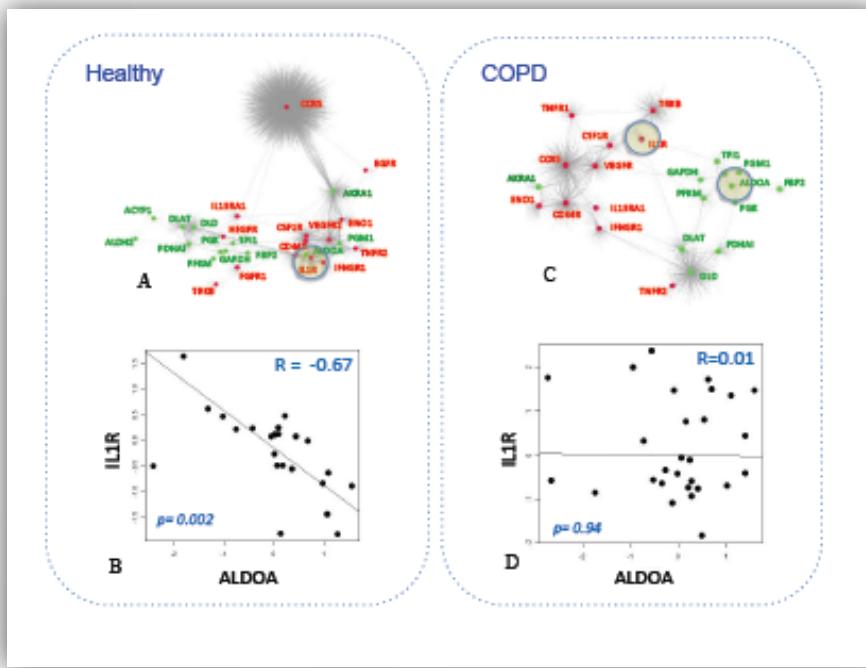
A Systems Biology Approach Identifies Molecular Networks Defining Abnormalities in COPD

Turan, Nil et al. PLoS Computational Biology 2011



Biological Outcomes

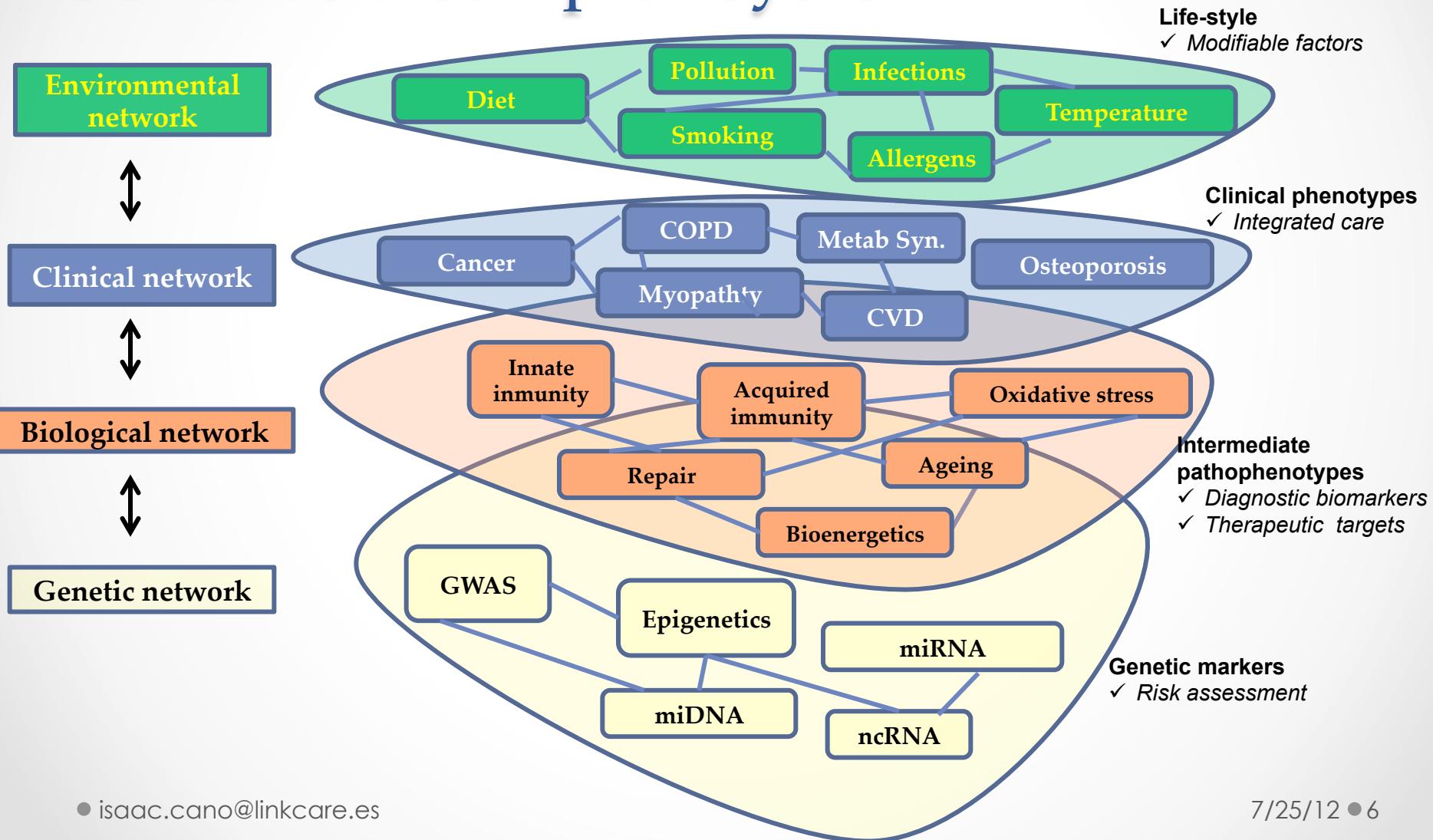
Lack of correlation between bioenergetics and tissue remodelling in COPD patients



Skeletal muscle in COPD patients seems to present abnormal interactions among:

- Increased nitroso-redox stress
- Cell bioenergetics
- Inflammatory signaling
- Tissue remodeling

COPD as a complex system



Data Integration & Inference

Modelling and Simulation environment for Systems Medicine
(Chronic Obstructive Pulmonary Disease -COPD- as a use case)



Towards personalized health

ICT as enabler of a new model of health care

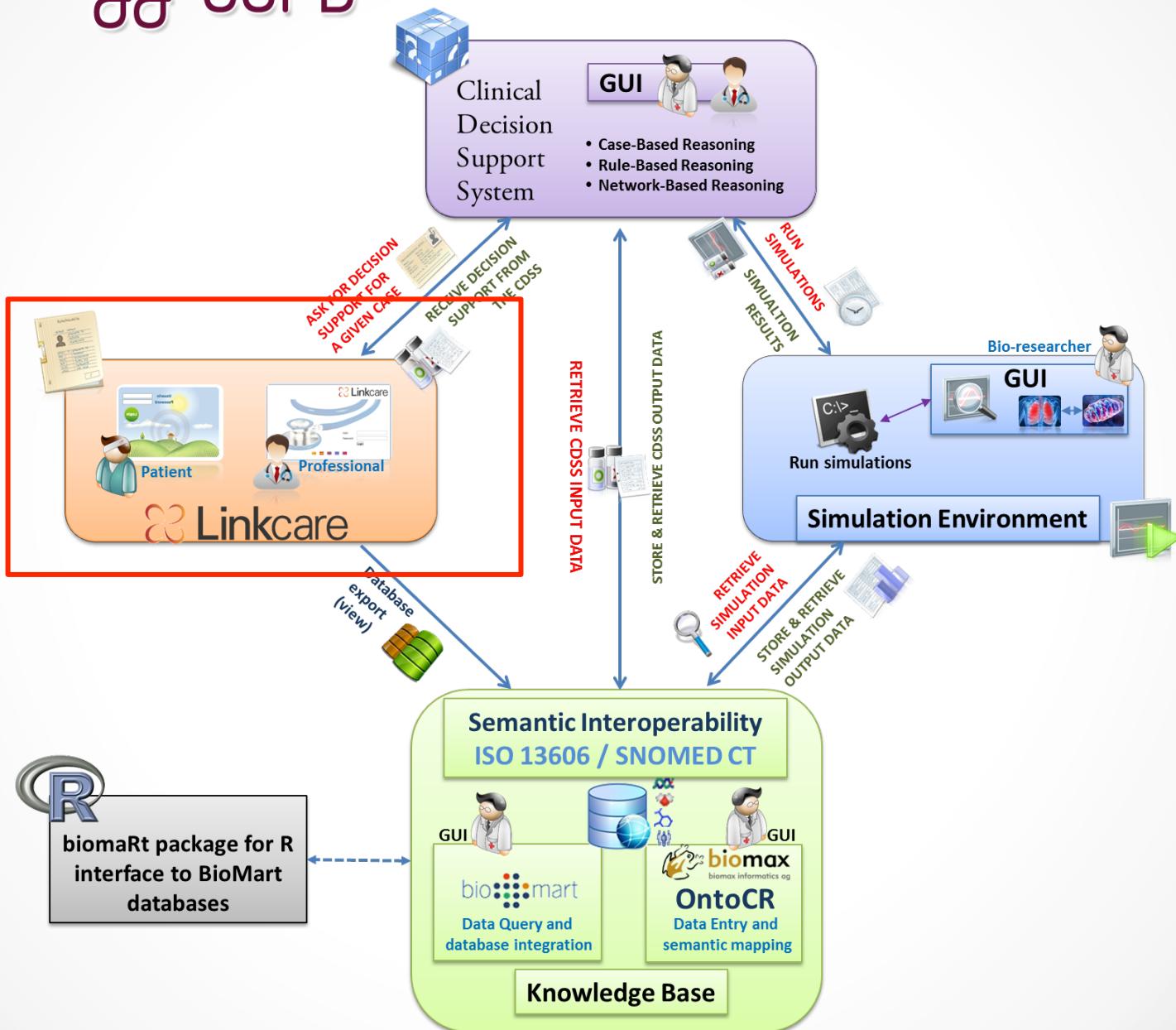
4C medicine

Continuous processes
Communication
Collaboration
Confidentiality

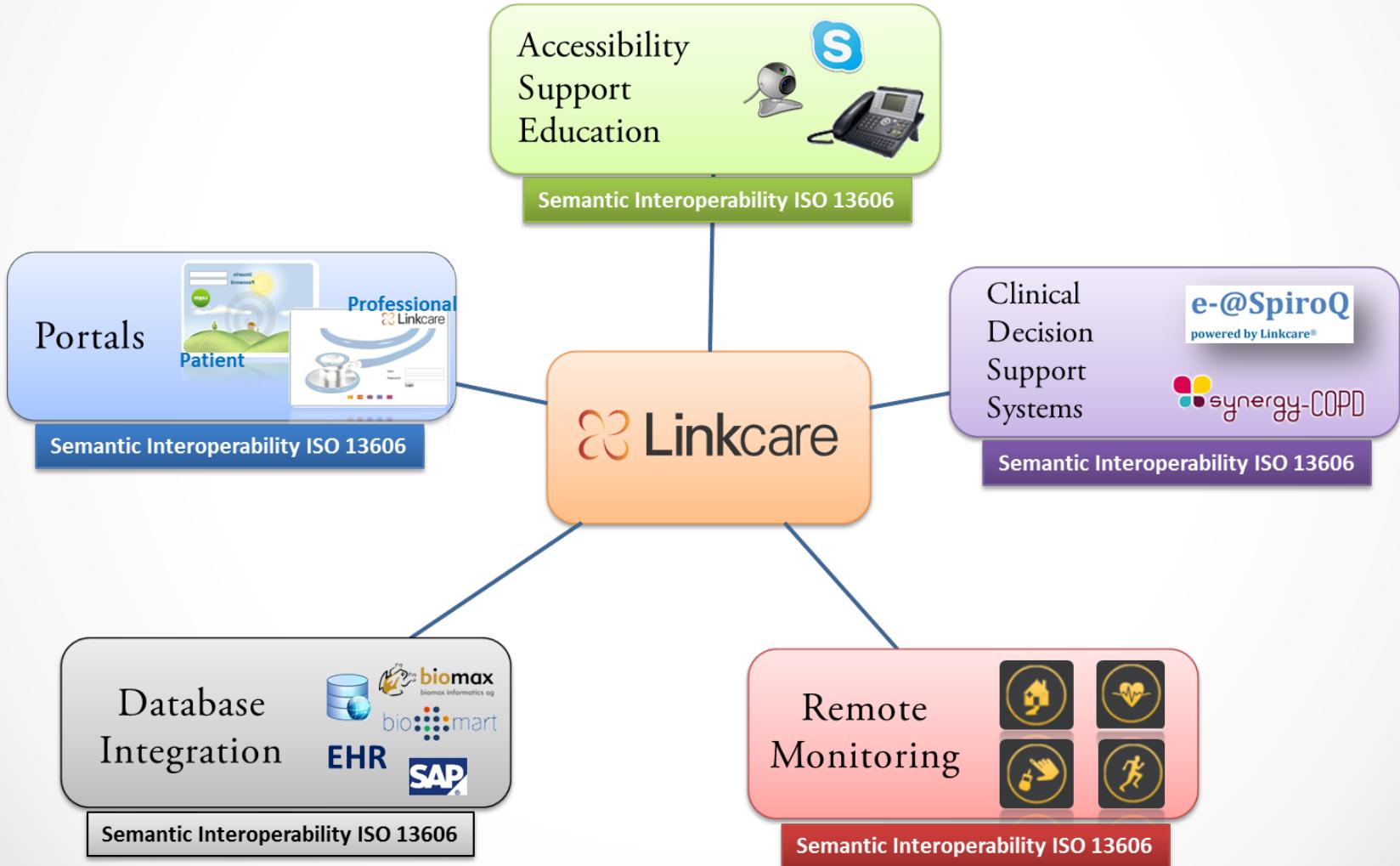
4P medicine

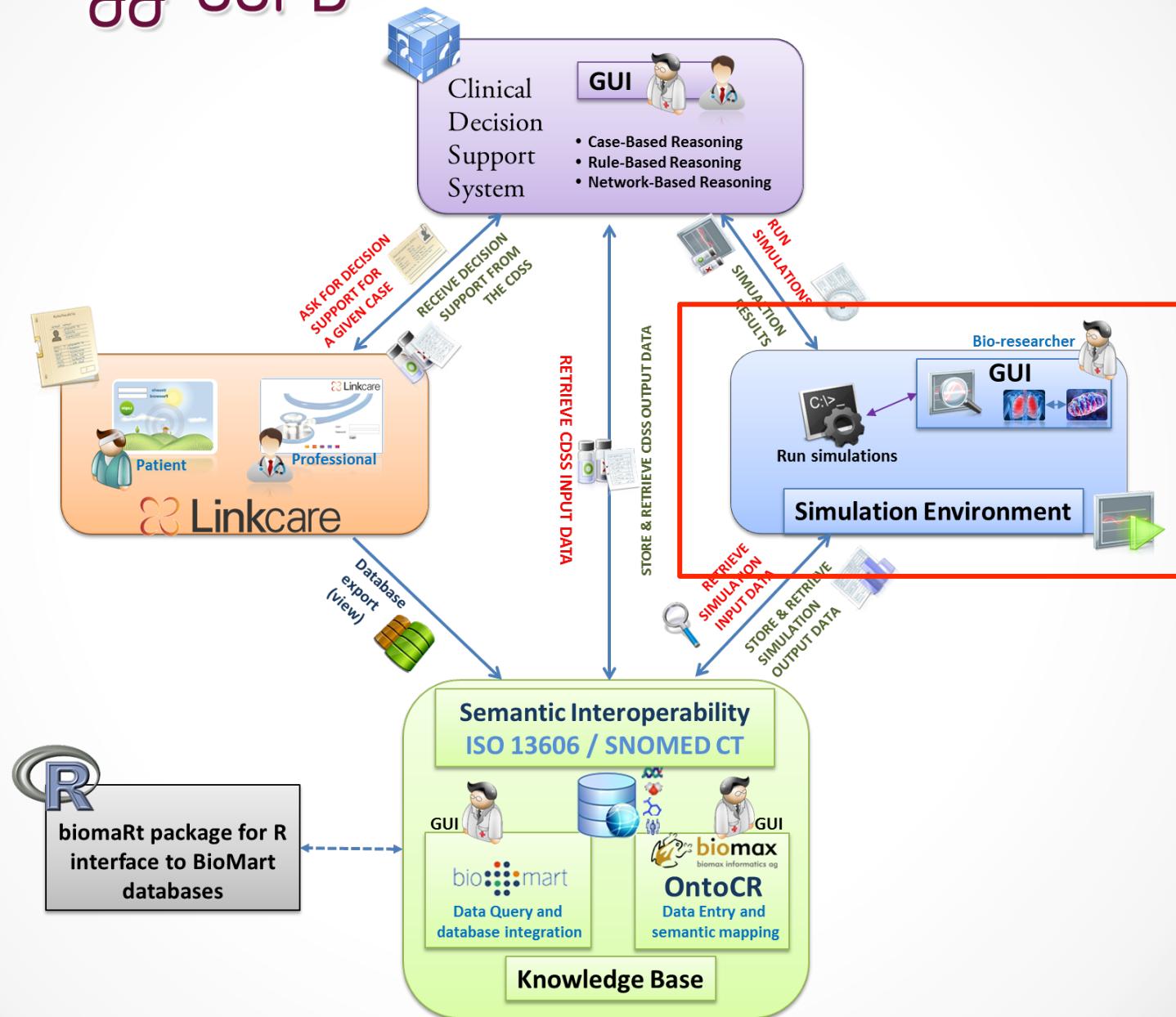
Predictive
Personalized
Preventive
Participatory

Efficient patient management
Modulation of disease progress



ICT-supported Integrated Care





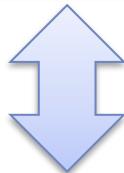
Model Integration & Simulation

Aim: *To study the cross-talk between the lungs, the cardiovascular system and the skeletal muscles*

Vertical integration (deterministic models)

Prof. Peter D. Wagner (USA)

- **Model 1:** Central and peripheral O₂ transport and utilization.
- **Model 2:** Pulmonary gas exchange.
- **Model 3:** Regional-lung heterogeneities in ventilation and perfusion.



Dr. Marta Cascante (UB)

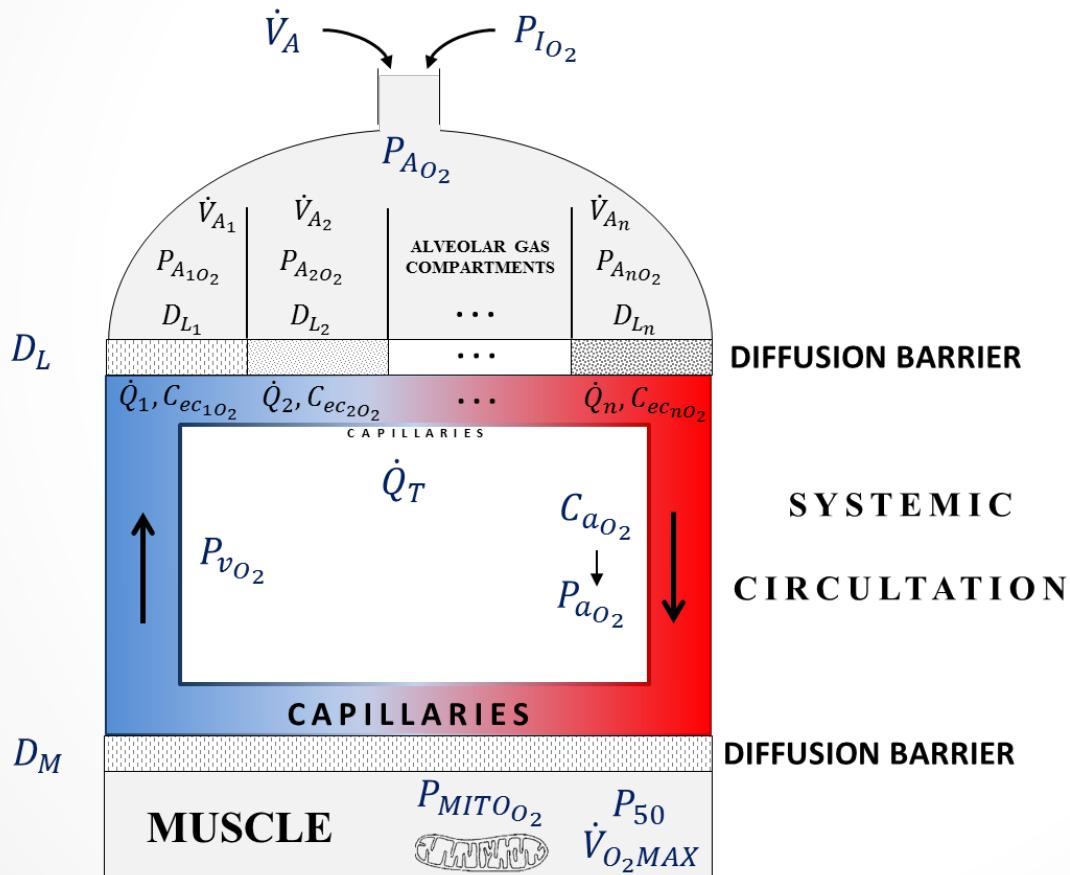
Dr. Vitaly Selivanov (IDIBAPS, UB)

- **Model 4:** Skeletal muscle bioenergetics.
- **Model 5:** Mitochondrial ROS generation.



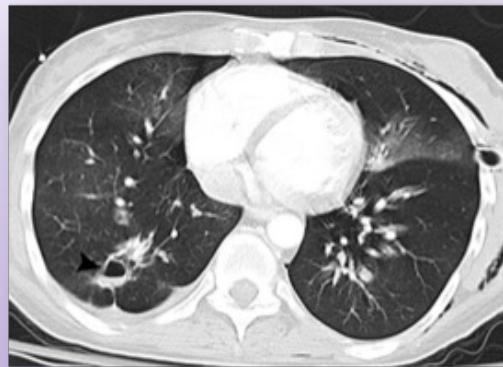
Model Integration & Simulation

Deterministic modelling: Oxygen transport and utilization with lung functional heterogeneities (Wagner, Peter D)



Model Integration & Simulation

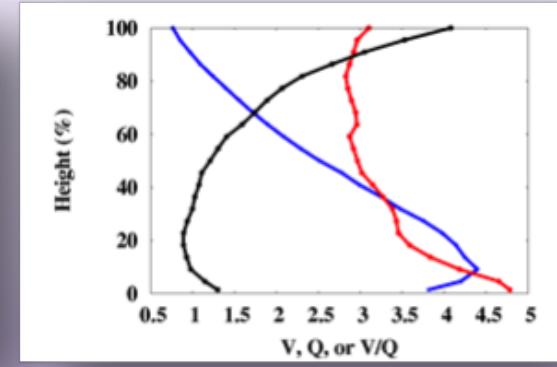
Deterministic modelling: Spatial heterogeneities of lung ventilation and perfusion (Kelly Burrowes, Oxford (UK))



A



B



C

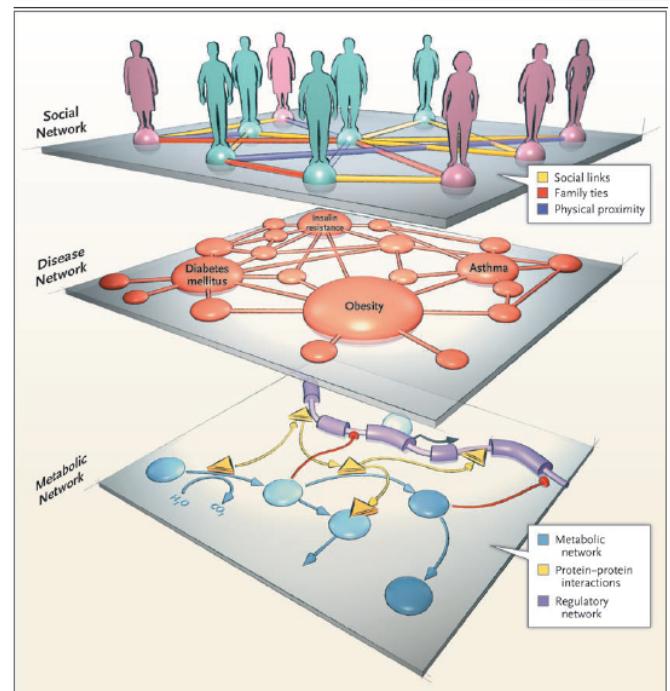
(A) CT image providing patient data. (B) Acinar data points created within the lung volume. (C) Prediction of alveolar ventilation (VA) and blood flow is made at each of the acinar points in (B) based on known correlations of VA, Q, and patient measured values.

Model Integration & Simulation

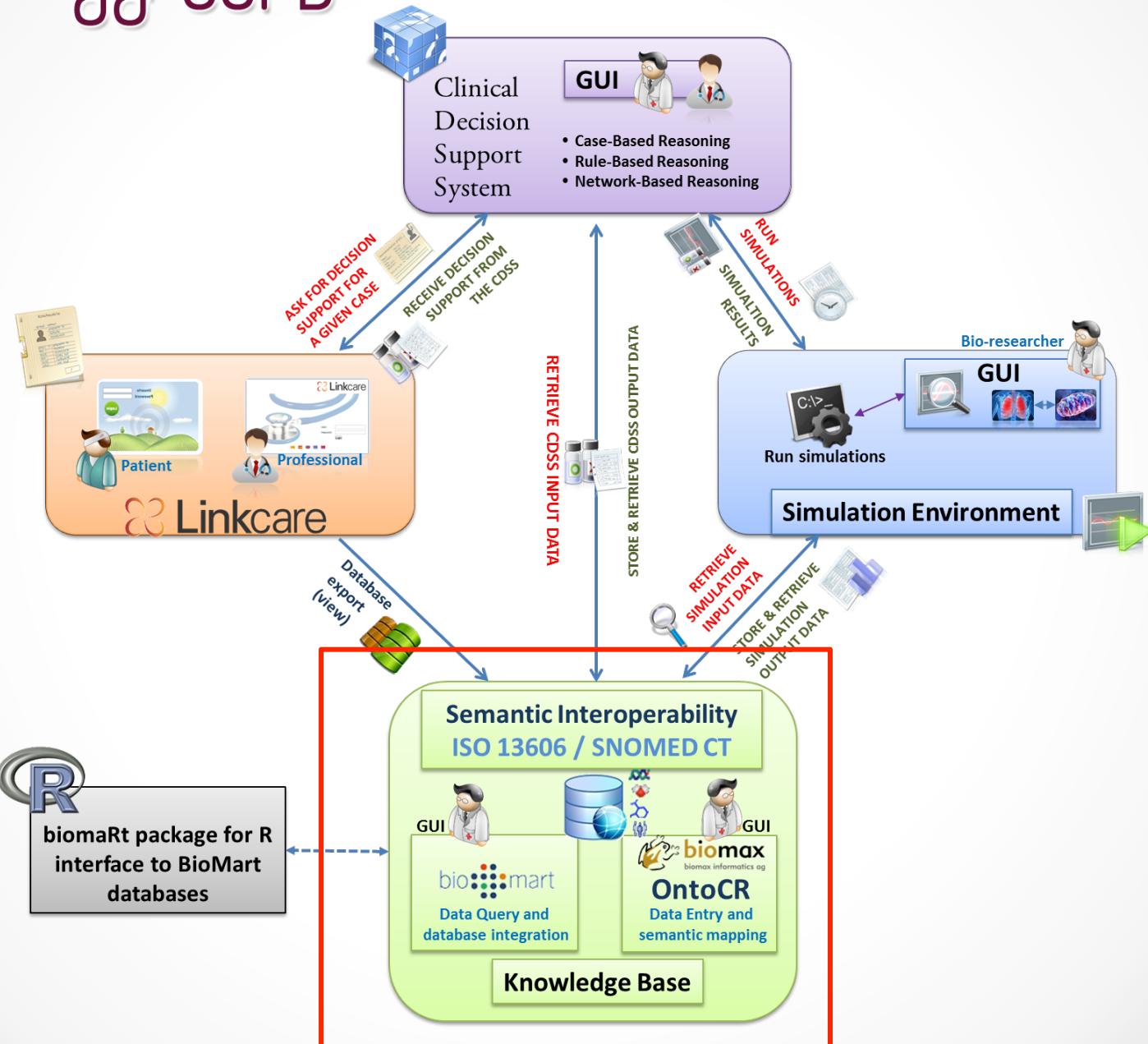
Aim: To model the uncertainty derived from the deterministic modelling.
To investigate the underlying mechanisms between inflammation and remodeling.

Horizontal integration (probabilistic modelling) → Network Medicine

- Develop large-scale network models that capture the disease states.
- Build an interactome map by combining protein-protein, metabolic and regulatory interactions.
- Test the predictions of the disease network models on patient data.



Barabási, New England Journal of Medicine (2007)



A new research paradigm

Bio-computing approach

Display and analysis of a large number of very heterogeneous variables:

- Genes.
- Proteins.
- Metabolites.
- Physiological data.
- Clinical data.
- Epidemiological info.
- Imaging data.



COPD Knowledge Base

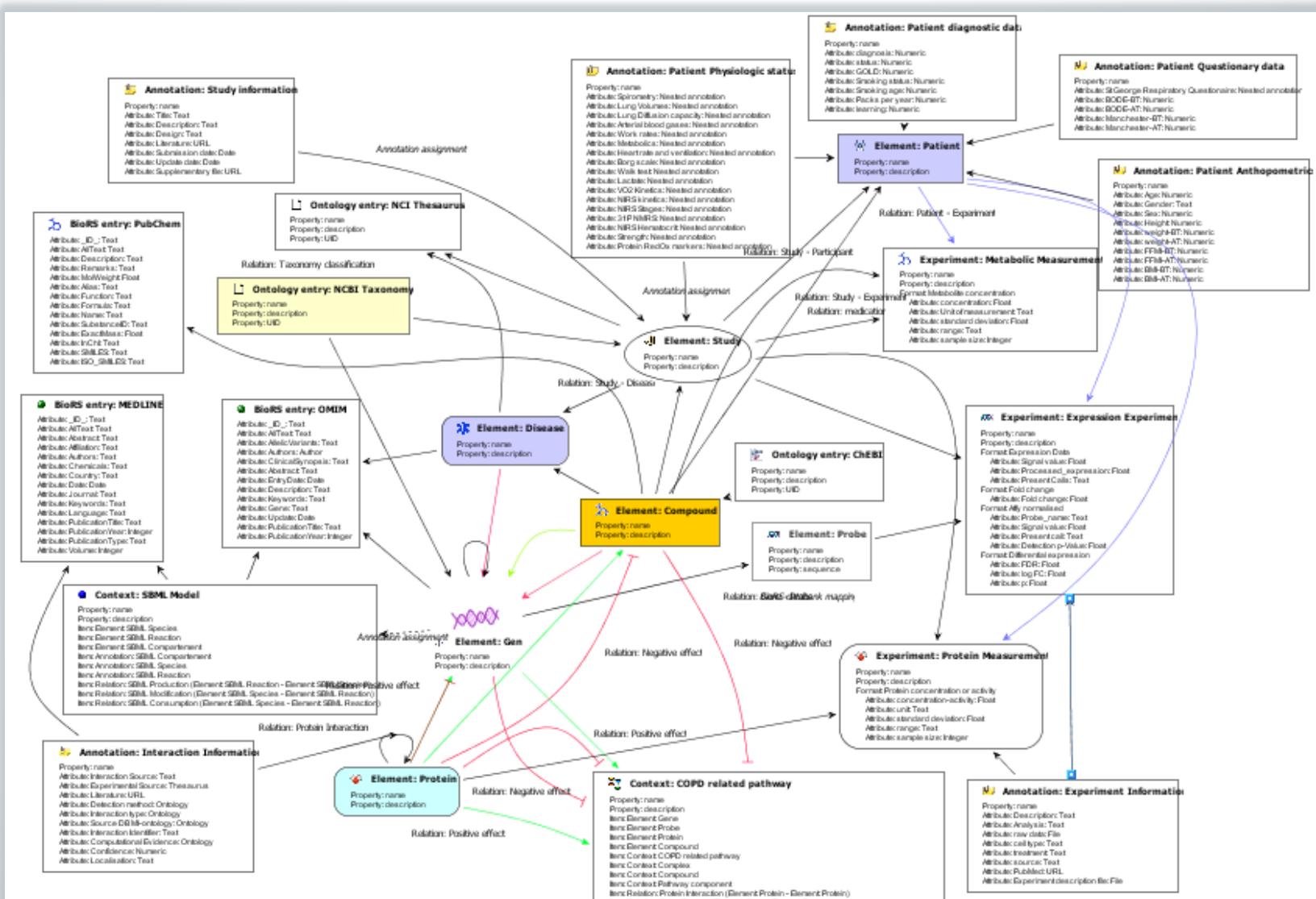
www.copdknowledgebase.eu

Explore and query the data: By bringing complex data together, it will make it possible for scientists to query and explore the data and find new relationships among the factors that contribute to the complex pathogenesis of COPD.

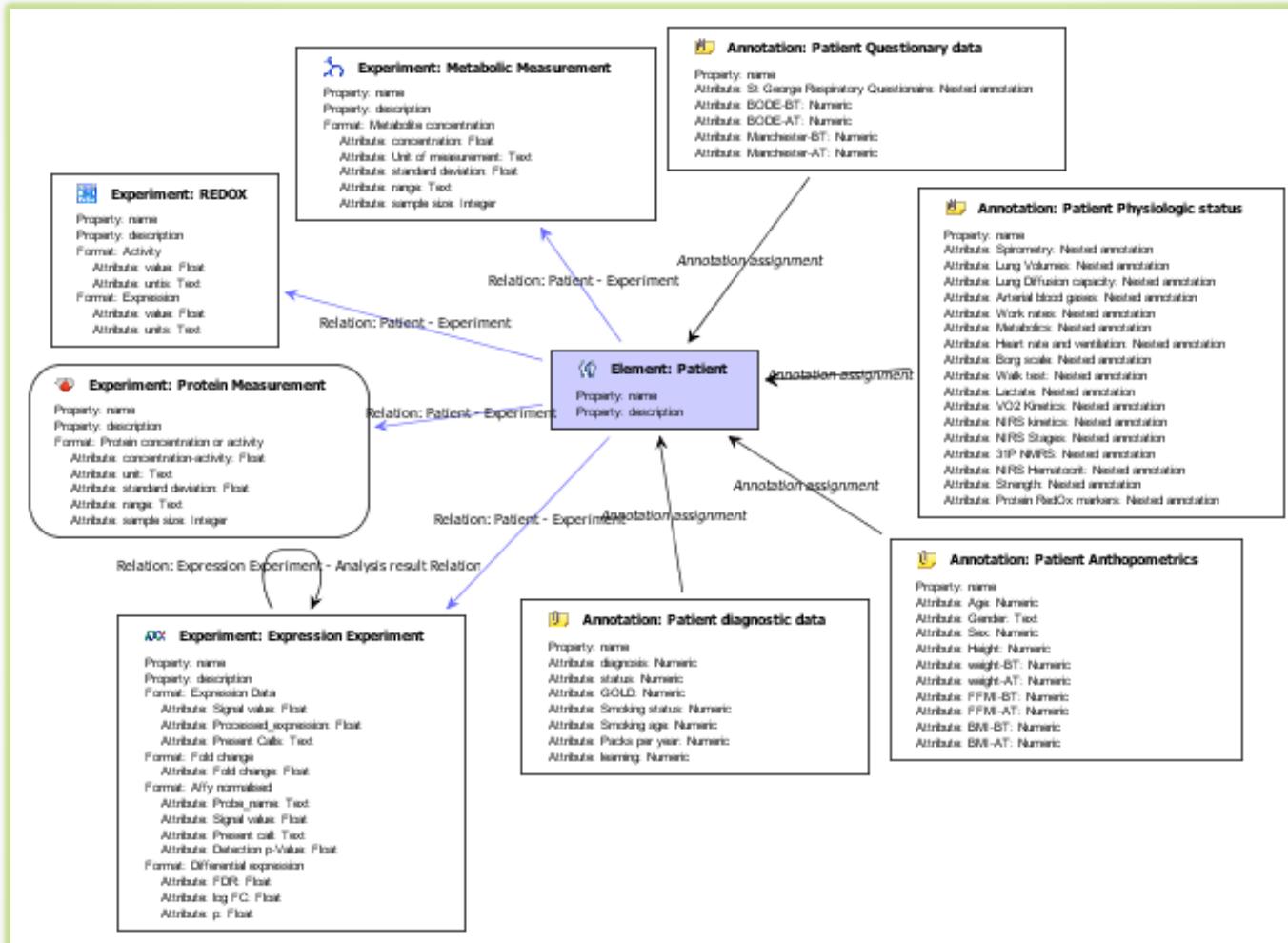
Data Integration: Scientists will be able to refine the biological data query according to various criteria, including experimental setup, gene expression analyses and disease links, as well as cross-species analyses.

Generic framework: The data model will be generic so that it can be extended to other chronic diseases (e.g., Diabetes type II, Chronic Heart Failure) and the system can be re-used by other research groups.

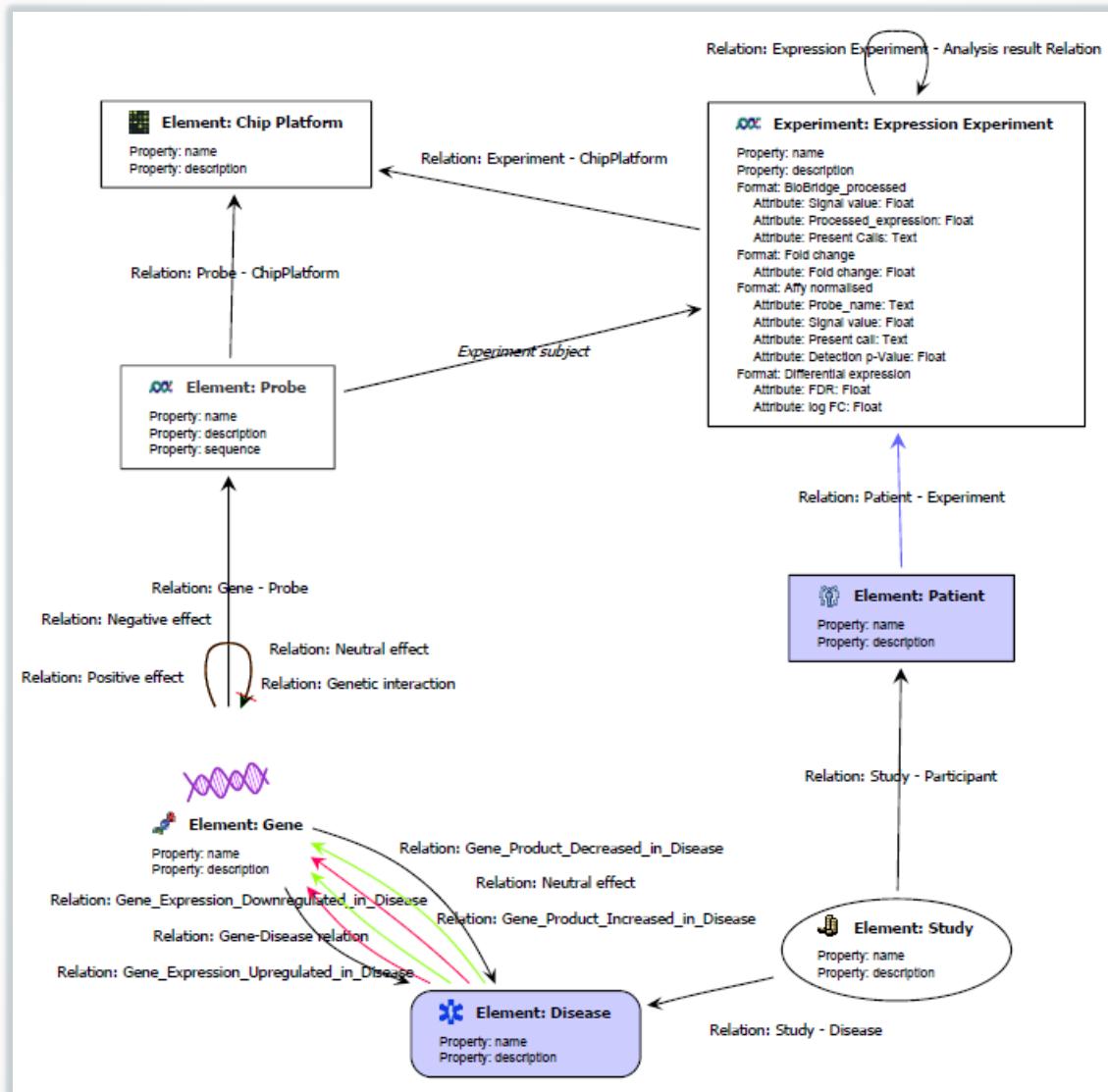
Data Integration model (BioXM)

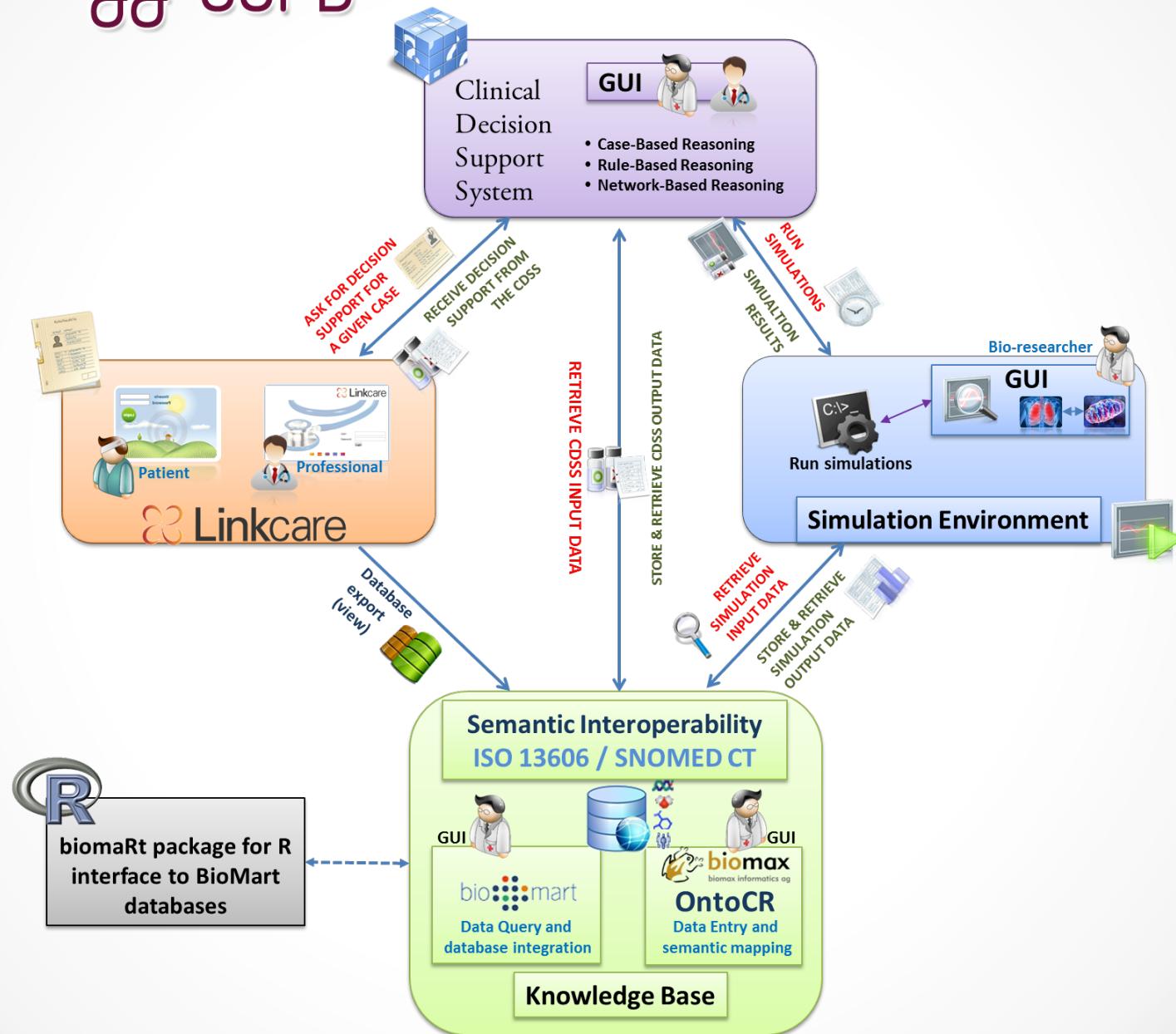


Experimental data integration (BioXM)



Gene expression data integration (BioXM)





Questions?

